Draft Habitat Connectivity Planning for Selected Focal Species in the Carrizo Plain

The primary objectives of the proposed project are to assist the California Energy Commission with modeling baseline conditions of habitat connectivity in the Carrizo Plain for select focal species (kit fox, tule elk, and pronghorn sheep); evaluating three proposed solar projects to measure and illustrate the impacts to connectivity; and modeling proposed mitigation strategies to evaluate their effectiveness to offset habitat loss and fragmentation.

Vast natural landscapes have been preserved as public and private conservation lands in order to protect their biological and ecological values and the plant and animal species that depend on them. Due to the spatial extent and management of natural habitats in the Carrizo Plain, they have become important refuges for many native plant and wildlife species.

Unfortunately, human development has threatened many native species by converting much of our natural landscape to agriculture, cities, and freeways, which fragment native habitats and limit movements by species and essential ecological processes among the remaining habitat areas. Habitat loss and fragmentation is a concern throughout the country and urban expansion into wildland areas is expected to continue.

Research has shown that strategically conserving and restoring essential connections between these remaining habitat areas is an effective, and cost-effective, counter-measure to these adverse effects of habitat loss and fragmentation. Our wild legacy can be sustained provided that our remaining natural areas are functionally connected into a large network of open space. This process requires identifying and prioritizing those connections that are

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Box A:

Key Connectivity Planning Terms

Connectivity: The degree to which a landscape facilitates movement by organisms or processes; the antithesis of habitat fragmentation.

Linkage: A landscape connection that facilitates movement between large, core habitat areas for diverse organisms and processes.

Corridor (aka **Wildlife Movement Corridor)**: A particular type of linkage that provides a continuous connection to facilitate wildlife movement between habitat patches, generally through areas less suitable for movement . Corridors are usually identified or designed for particular species based on species-specific requirements, and may or may not be linear habitat features.

Movement Barrier: A physical obstruction or break in habitat continuity that prevents all or nearly all movement by a particular species or process, such as a major freeway that isolates wildlife populations on either side.

Movement Filter: A physical obstruction or break in habitat that reduces movement or increases mortality rates for wildlife crossing it, but doesn't prevent all movements; for example, a highway that can be crossed but with substantial risk of roadkill.

Crossing Structure: A physical structure, such as an overpass or underpass, that facilitates wildlife movement across movement barriers or filters, such as a highway or a canal.

most essential to maintaining healthy populations of native plants and animals. Habitat connectivity planning can help prevent additional species from being listed, stabilize existing populations, and prevent costly long-term recovery efforts.

Through the successful completion of this project, the California Energy Commission will be able to take into account essential habitat connectivity and wildlife movement corridors in their planning processes for the proposed solar projects.

SC Wildlands has collaborated closely with several agencies and organizations for years to produce successful landscape connectivity designs throughout southern California, many of which are already being implemented (see Box B). Our team has proven expertise in management, facilitation, organization, connectivity analysis, landscape ecology, wildlife biology, geospatial modeling and analysis, consensus planning with diverse groups, and report writing and organization. The technical and planning approaches we have developed are based on approaches that have proved highly successful for us in producing science-based and consensus-based linkage conservation plans in California and Arizona.

Box B:
A Proven Approach
Our collaborative approach and extensive network of cooperating agencies have integrated the South Coast Missing Linkages initiative into policy decisions. For example, our efforts were cited by the California Department of Fish & Game's recently published State Wildlife Action Plan as follows: "To address regional habitat fragmentation, federal, state, and local agencies, along with nongovernmental conservation organizations, should support the protection of the priority wildland linkages identified by the South Coast Missing Linkages project." Similarly, when the four National Forests in southern California recently finalized their Resource Management Plans, they identified connecting the four forests to the existing network of protected lands as one of the key strategies for protecting biodiversity on the forests. In addition, several NCCP's in southern California, the recent Green Visions Plan, and the regional open space plan adopted by Southern California Association of Governments have made it a top conservation priority to implement South Coast Missing Linkage designs.

Hallmarks of our approach have included rigorous quantitative methods and highly collaborative planning. Our team has a long history of working closely and collaboratively with many individuals that will likely be part of this effort, including federal, state, and local agency scientists, land managers, and planners.

We have extensive experience building complex GIS datasets and assembling existing files from multiple sources, scales, and projections and have an intimate knowledge of habitat connectivity planning and the analytic tools designed to address this issue. Team members have authored numerous peer reviewed publications on applying GIS to address various aspects of conservation planning.

OBJECTIVES & METHODS

SC Wildlands will model baseline conditions of habitat connectivity in the Carrizo Plain for select focal species; evaluate three proposed solar projects to measure and illustrate the impacts to connectivity; and model proposed mitigation strategies to evaluate their effectiveness to offset habitat loss and fragmentation.

Task 1: Model Baseline Conditions of Habitat Connectivity in the Carrizo Plain for Select Focal Species.

Step 1:   Landscape Permeability Analysis & Coordination with Experts

Landscape permeability analysis is a GIS technique that models the relative cost for a species to move between core areas based on how each species is affected by habitat characteristics, such as slope, elevation, vegetation composition, and road density. This analysis identifies a least-cost corridor, or the best potential route for each species between targeted core areas (Walker and Craighead 1997, Craighead et al. 2001, Singleton et al. 2002). The purpose of the analysis is to identify land areas, which would best accommodate select focal species living in or moving through the linkage (Beier et al. 2005).

Permeability Model Inputs: elevation, vegetation, topography, and road density. Landscape permeability analysis models the relative cost for a species to move between core areas based on how each species is affected by various habitat characteristics.
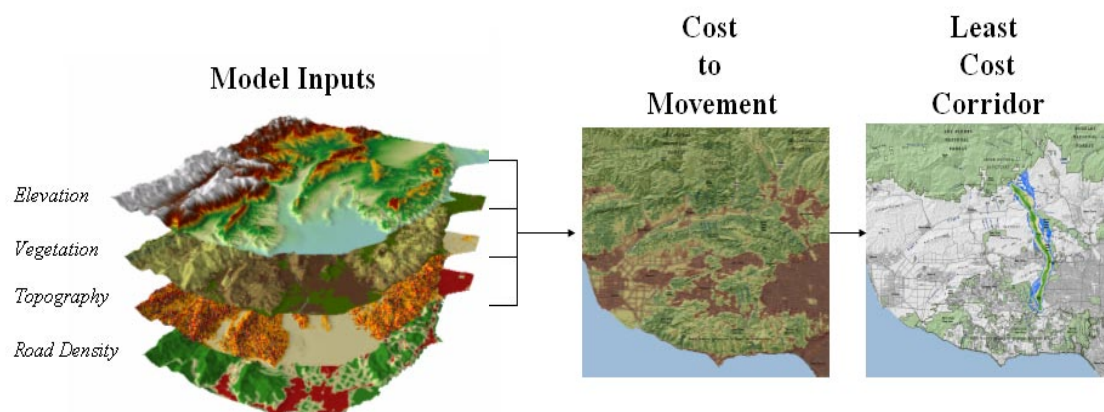
The relative cost of travel will be assigned for each species based upon its ease of movement through a suite of landscape characteristics (vegetation type, road density, and topographic features). The following spatial data layers will be assembled at 30-m resolution: vegetation, roads, elevation, and topographic features. If necessary, data layers (i.e., vegetation, roads) will be updated using recent 1-m resolution aerial photographs prior to conducting the analyses. We derived four topographic classes from elevation and slope models: canyon bottoms, ridgelines, flats, or slopes. Road density will be measured as kilometers of paved road per square kilometer. Within each data

layer, we will have experts rank all categories between 1 (preferred) and 10 (avoided) based on focal species preferences as determined from available literature and expert opinion regarding how movement is facilitated or hindered by natural and urban landscape characteristics. Each input category will be ranked and weighted, such that: (Vegetation * w%) + (Road Density * x%) + (Topography * y%) + (Elevation * z%) = Cost to Movement, where w + x + y + z = 100%.

Weighting allows the model to capture variation in the influence of each input (vegetation, road density, topography, elevation) on focal species movements. A unique cost surface is thus developed for each species. A corridor function is then performed to generate a data layer showing the relative degree of permeability between core areas.

Running the permeability analysis requires identifying the endpoints to be connected. Usually, these targeted endpoints are selected as medium to highly suitable habitat within protected core habitat areas (e.g., National Forests, State Parks) that needed to be connected through currently unprotected lands. However, since habitat areas to the north of the proposed project are not currently protected, we will need to define a targeted core habitat area in order to give the model broad latitude in interpreting functional corridors across the entire study area.

For each focal species, the most permeable area of the study window will be designated as the least-cost corridor. The least-cost corridor output for all focal species will then be combined to generate a Least Cost Union. The biological significance of this Union can best be described as the zone within which all three modeled species would encounter the least energy expenditure (i.e., preferred travel route) and the most favorable habitat as they move between targeted areas. The output does not identify barriers, mortality risks, dispersal limitations or other biologically significant processes that could prevent a species from successfully reaching a core area. Rather, it identifies the best zone available for focal species movement based on the data layers used in the analyses.

We will coordinate with biologists in the region who are considered experts on the selected focal species to rank the criteria for the analyses. Clevenger et al. (2002. Expert-based models for identifying linkages. Conservation Biology 16:503-514) found that expert-based models that did not include a literature review performed significantly worse than literature-based expert models. Therefore, we ask each participating expert to assemble all papers on habitat selection by the focal species or closely-related species. This is important because we want to document how our models were parameterized. Careful use of, and citation of, the literature will give us a more credible product, and one that is more likely to influence conservation decisions.

Step 2: Habitat Suitability, Patch Size & Configuration Analyses

Although the Least-Cost Union identifies the best zone available for movement based on the data layers used in the analyses, it does not address whether suitable habitat in the Union occurs in large enough patches to support viable populations and whether these patches are close enough together to allow for inter-patch dispersal. We therefore

conduct patch size and configuration analyses for all focal species and adjust the boundaries of the Least Cost Union where necessary to enhance the likelihood of movement.

A habitat suitability model forms the basis of the patch size and configuration analyses. Habitat suitability models will be developed for each focal species using the literature and expert opinion. Spatial data layers used in the analysis will vary by species. We will generate a spectrum of suitability scores that will be divided into five classes using natural breaks: low, low to medium, medium, medium to high, or high. Suitable habitat will be identified as all land that scored medium, medium to high, or high.

To identify areas of suitable habitat that are large enough to provide a significant resource for individuals in the linkage, we will conduct a patch size analysis. The size of all suitable habitat patches in the planning area will be identified and marked as potential cores, patches, or less than a patch. *Potential core areas* will be defined as the amount of contiguous suitable habitat necessary to sustain at least 50 individuals. A *patch* will be defined as the area of contiguous suitable habitat needed to support at least one male and one female, but less than the potential core area. Potential cores are probably capable of supporting the species for several generations (although with erosion of genetic material if isolated). Patches can support at least one breeding pair of animals (perhaps more if home ranges overlap greatly) and are probably useful to the species if the patch can be linked via dispersal to other patches and core areas.
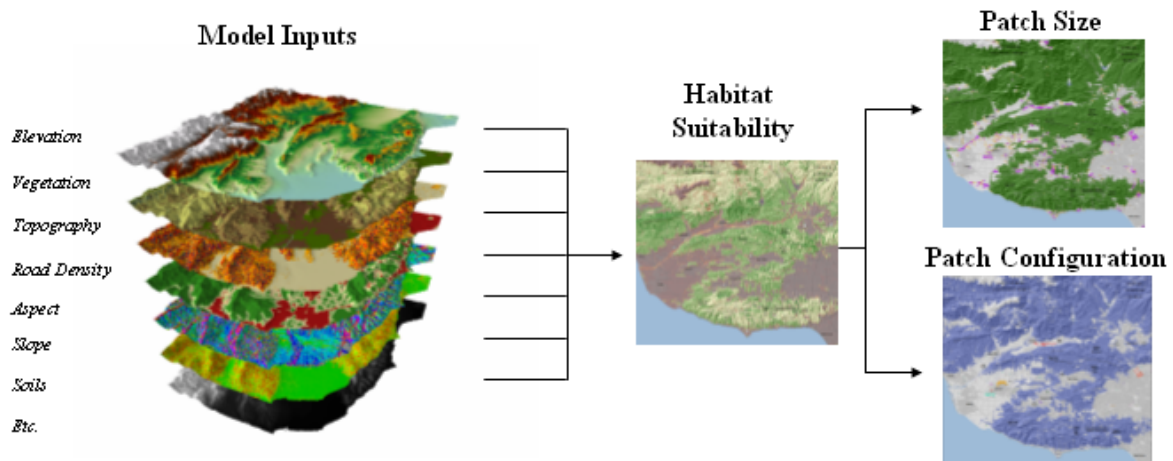
Model Inputs to Patch Size and Configuration Analyses vary by species. Patch size delineates cores, patches, and stepping-stones of potential habitat. Patch configuration evaluates whether suitable habitat patches and cores are within each species dispersal distance.

To determine whether the distribution of suitable habitat in the linkage supports meta-population processes and allows species to disperse among patches and core areas, we will conduct a configuration analysis to identify which patches and core areas were

functionally isolated by distances too great for the focal species to traverse. Because the majority of methods used to document dispersal distance underestimate the true value (LaHaye et al. 2001), we assumed each species can disperse twice as far as the longest documented dispersal distance. This assumption is conservative in the sense that it retains habitat patches as potentially important to dispersal for a species even if it may appear to be isolated based on known dispersal distances.

For each species we compare the configuration and extent of potential cores and patches, relative to the species dispersal ability, to evaluate whether the Least Cost Union will likely serve the species. If necessary, we add additional habitat to help ensure that the linkage provides sufficient live-in or "move-through" habitat for the species' needs.

The analyses described above will be performed for the selected focal species to determine baseline conditions.

Task 2: Evaluate Three Proposed Solar Projects in Relation to Baseline Conditions to Measure and Illustrate the Impacts to Connectivity

To quantify impacts of the three proposed solar projects we will evaluate the configuration and extent of each project as proposed in relation to baseline conditions for the selected focal species to measure and illustrate impacts to connectivity, and to determine each project's proportion of the cumulative impacts. We will provide maps and spatially-explicit descriptions of existing and proposed impediments to wildlife movement through the assessment area.

Task 3: Model Proposed Mitigation Strategies to Evaluate their Effectiveness to Offset Habitat Loss and Fragmentation

We will model proposed mitigation strategies to evaluate their effectiveness to offset habitat loss and fragmentation caused by the proposed solar projects. We will provide a description and mapping of alternative mitigation strategies to maintain adequate buffer width and habitat connectivity, with a recommended strategy for conservation action.

Task 4:   Draft Report and Peer Review

We will coordinate with the scientists who provided the rankings for each focal species to review the results of the model output for scientific accuracy. Draft reports will be circulated to all project partners and to our Science Advisory Panel to review the conclusions and provide comments on the report.

Task 5:   Final Report

The final report will incorporate comments from project partners and peer reviewers. We will provide a digital version of the final document, along with one hard copy.